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A Report on Biomass Production Projects

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BioMass Production:

LED Lighting Project: Second prototype array. Since our initial NSCORT research with a first prototype LED lighting array, we have developed and obtained a second array. Significant upgrades were instituted in the second array. First, half of the individual lighting strips or 'lightsicles' were constructed with an additional 17.8 cm of length in the tubular support located between the top light engine and the bottom of the electronics enclosure on each lightsicle. This allows the shorter lightsicles to nestle beneath the electronics enclosure of the longer lightsicles in the intracanopy (IC) configuration, thus allowing closer grouping of lightsicles and a much wider variety of possible configurations. Reconfiguring the IC arrangement led to more uniform distribution of light within the canopy.

A second significant upgrade to the LED array was a software modification developed by Orbitec. This modification caused a change in the allocation of power to particular drivers, which resulted in the ability to obtain uniform light levels from a particular light engine regardless of the number of other engines energized on the same strip.

LED Lighting Project: Side-by-side intracanopy versus overhead experiments. Following five trials with the first LED array in either the IC or OH configuration, the original array has been maintained in the OH configuration, and the second prototype is in the IC configuration. The first of these experiments was conducted using cowpea, with two groups of 30 plants (129 plants/m²) grown simultaneously for 32 days. The data clearly demonstrate that plants grown under the OH array were less productive than plants grown with IC lighting. Even more impressive are the numbers for grams dry weight per Kilowatt-hour of electricity consumed, 1.14 for the IC plants compared to 0.67 for the OH-lit plants. This value for the IC-grown plants also exceeds the previous maximum obtained in Trial 4 (0.98 g/kW-h), although the total g DW decreased (from 96.37 g in trial 4 to 84.46 g in the IC comparison). This, coupled with a decrease in the average g DW per plant, indicates that competition within the more dense canopy for light and other resources was occurring. Also, during this trial it was observed that the plants grown with the IC lighting displayed some degree of leaf intumescence growth, while those grown under the OH array did not. The higher percentage of blue light in the OH array may have inhibited the formation of intumescence growths on the leaves. Since intumescence had never previously been observed on the plants grown in trials 1-5, it is likely that the blue:red ratio was high enough for those trials as well, although this ratio likely changed with increasing numbers of light engines energized.

Based on the findings of these experiments, thorough analysis of blue and red levels, independently of each other, were made for each array stepwise as each light engine was energized. In the interest of determining the potential of LEDs for crop production involving reproductive development, a side-by-side IC vs. OH comparison using 'Triton' pepper was begun on April 28, 2006. After almost one month of growth, the plants showed severe intumescence symptoms, and at that time the LED settings were adjusted to provide 15% of the incident PAR from the blue LEDs. This adjustment did not appear to mitigate the intumescence

symptoms. Harvesting continues and initial results show that flowers and fruit form and ripen normally under both lighting conditions, in spite of intumescence.

LED Lighting Project: Gas exchange. The design of the Minitron 3 gas-exchange cuvette system for intracanopy LED lighting of small crop stands is nearly complete. A transpiration study was conducted in conjunction with the first side-by-side IC versus OH experiment discussed earlier. This experiment culminated in an ICES paper and will be discussed in a report in the systems group focus area.

Extending Crop Harvest Index Using Edible Fungi

Experiments were conducted to determine best wheat straw particle size (coarse, medium, fine) for closed system fungal culture, assess various sources of nitrogen for enhancing growth in select strains of shiitake (*Lentinula edodes*) and maitake (*Grifola frondosa*), and to investigate cropping patterns for greater mycelial colonization and degradation of various crop residues. Fine textured wheat straw (particles pass through 2mm sieve) was most promotive to fungal growth. Our studies demonstrated conclusively that the oyster mushroom (*Pleurotus ostreatus*) strain 'Grey Dove' is best for degrading lignocellulosic wastes and recycling food residues and sludge. A 72% or higher degradation efficiency was achieved by recombining spent mycelia and residual undegraded crop material with strain 'Grey Dove'.

Tilapia Fish In Space

Utilization of wastes. Working with collaborators associated with the Center, waste products were collected. Wastes evaluated included a wheat bran/wheat germ mixture, non-edible biomass from soybean (SB), sweet potato (SP), cowpea (CP) and basil (B), and bacterial residue from an autothermal thermophilic aerobic digester (TB). Experimental diets consisted of 98% waste product and 2% binder to facilitate pelleting. All diets were accepted by tilapia and all treatment groups gained weight.

Our goal was to continue characterizing waste products as colleagues evaluated various plant and food sources, then develop a balanced diet for tilapia using the chemical characterization data and test our mixed diets in a subsequent study in year 5.

Growth was inversely related to fiber concentrations and directly related to methionine concentration, an essential amino acid.

Composted waste. Cowpea waste was acquired from colleagues at Purdue and shipped to Alabama A&M for composting. Based on these data, composting with the oyster mushroom did not significantly alter the fiber component of the residue. Feeding either product resulted in negative weight gain in juvenile tilapia

First-feeding diets. One of the more important considerations, and one that had not been addressed in research studies with tilapia, was their ability to use plant-based diets at first feeding. We developed an all-plant ingredient basal diet for tilapia and that diet appeared deficient in three essential amino acids

(methionine, threonine and lysine). Based on these data, first feeding tilapia can be fed plant-based diets without sacrificing weight gain.

Mineral balance in aquaponics. Based on observations from an established aquaponic system, boron, iron and zinc appeared deficient for plant growth in integrated aquaponic systems. However, plant growth was suboptimal in this initial study. This subcomponent was used as a training module. Data developed are preliminary in nature, and were going to be used for a more formal evaluation.